OPERATING INSTRUCTIONS

TYPE 1554-A

SOUND AND VIBRATION ANALYZER

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OPERATING INSTRUCTIONS

TYPE 1554-A

SOUND AND VIBRATION ANALYZER

Form 1554-0130-C
May, 1962

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West Concord, Massachusetts, USA

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS, USA

SPECIFICATIONS

Frequency Range:	2.5 - 25,000 cps in four ranges.
Accuracy of Frequency Calibration:	±2% of frequency setting.
Input Voltage Range:	100 μv – 30 v for useful indication. Most sensitive range is 1 mv full scale.
Frequency Response:	NARROW: Max response flat ±2 db over entire tuning range. ONE-THIRD OCTAVE: Max response flat ±4 db over entire tuning range. ALL-PASS: Flat ±2 db from 2.5 cps to 25 kc.
Bandwidth:	NARROW: (See Figure 2.) Response down 3 db at ±4% of selected frequency. At ½ and 2 times selected frequency, response down over 40 db. ONE-THIRD OCTAVE: (See Figure 2.) Bandwidth is 1.26:1 at 3-db points. At ½ and 2 times selected frequency, response down over 30 db.
Input Impedance:	100,000 ohms, unbalanced. Low input terminal grounded to case.
Meter:	Three ranges: –10 to +10 db, 0 to 3 v, and 0 to 10 v.
Attenuator:	Adjustable in 10-db steps.
Minimum Levels for Direct Use with Microphone:	Microphone Type — Minimum Component Level 1560-P12** — 50 db re 0.0002 μbar 759-P25* — 50 db re 0.0002 μbar 1551-P1L — 50 db re 0.0002 μbar 1551-P1H — 65 db re 0.0002 μbar *Type 1550-P1 Adaptor required **Type 1560-P93 Adaptor required
Output:	Approx 1 v open-circuit at front-panel jack when meter indicates full scale. Output impedance 5 kilohms.
Tubes:	Four CK512AX, two CK526AX.
Transistors:	Seven 2N324, five 2N647, two TR-1, one 2N1183.
Batteries:	Four 1.5-v and two 67.5-v supplied (see Parts List). Battery life approx 100 hr.
Accessories Supplied:	Shielded cable assembly (Type 760-38) for connection to sound-level meter; cable assembly (Type CAP-11) for 115-v calibration; phone plug (Type CDMP-22) for output connection; pouch (Type 1606-42) and chain.
Accessories Available:	Airplane-luggage-type carrying case.
Dimensions:	10-5/8 by 15-3/8 by 11-1/2 in. (280 by 390 by 295 mm) over-all.
Weight:	31-1/2 lb (14.5 kg); with accessories and carrying case 39-3/4 lb (18.5 kg).

General Radio Experimenter reference: Volume 33 No. 12, December 1959

Special Request to the User of This Instrument

We believe that the most effective way to make our products more useful is to learn from the experience and opinions of those who use them. Your answers to the questions in this questionnaire, based on your experience in using this instrument, will be of great value to General Radio engineers and other personnel concerned with new products. Such comments will have a strong influence on the direction of future development work. The resulting better products will benefit our customers as well as ourselves.

The questionnaire is its own postage-paid envelope. Simply fold as directed, staple, and mail.

Any information you supply will not go outside our Company without your specific authorization. Your reply will be acknowledged, and your questions answered by GR engineers concerned with this instrument. May we have your comments?

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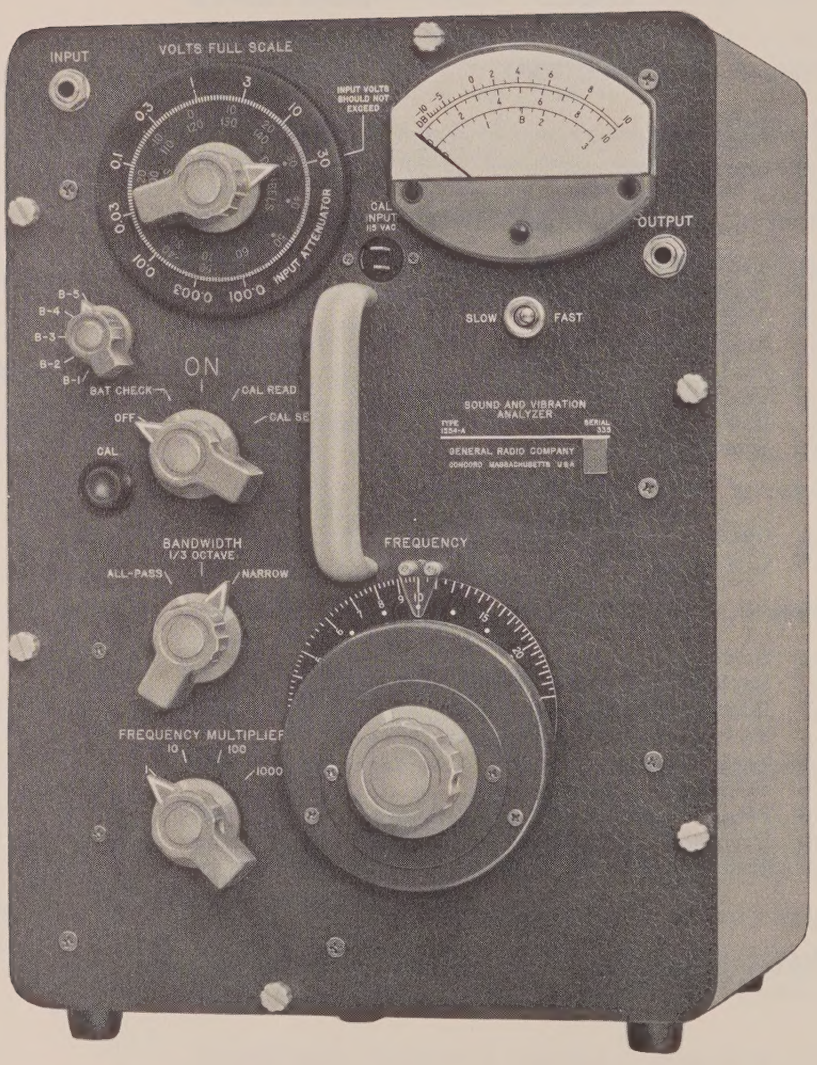


Figure 1. Type 1554-A Sound and Vibration Analyzer

TYPE 1554-A
SOUND AND VIBRATION ANALYZER

Section 1
INTRODUCTION

1.1 PURPOSE. The Type 1554-A Sound and Vibration Analyzer (Figure 1) is designed for the frequency analysis of electrical signals over the range from 2.5 to 25,000 cycles per second. As such, it is a valuable adjunct to the Sound-Level Meter or Vibration Meter in the measurement of sound or vibration.

A detailed description of noise and vibration measurements is given in the General Radio Handbook of Noise Measurement, available for $1.00. The Primer of Noise Measurement, an elementary treatise, is available free on request.

1.2 DESCRIPTION.

1.2.1 GENERAL. The Type 1554-A is battery-powered and portable. Three filter characteristics are provided: ONE-THIRD OCTAVE and NARROW, each continuously tunable in four ranges, and ALL-PASS, for the preliminary measurement of the entire input signal. The output is indicated on a panel meter, and the Analyzer's sensitivity is adjustable from 30 volts to 1 millivolt for full-scale meter indication. The filtered signal is available at the output jack for connection to other apparatus. The Analyzer can be calibrated in any of several ways: It can be made direct-reading in one-third-octave sound pressure level, in vibration amplitude, or simply in volts at the input jack.

The two filter response characteristics (ONE-THIRD OCTAVE and NARROW) are shown in Figure 2.

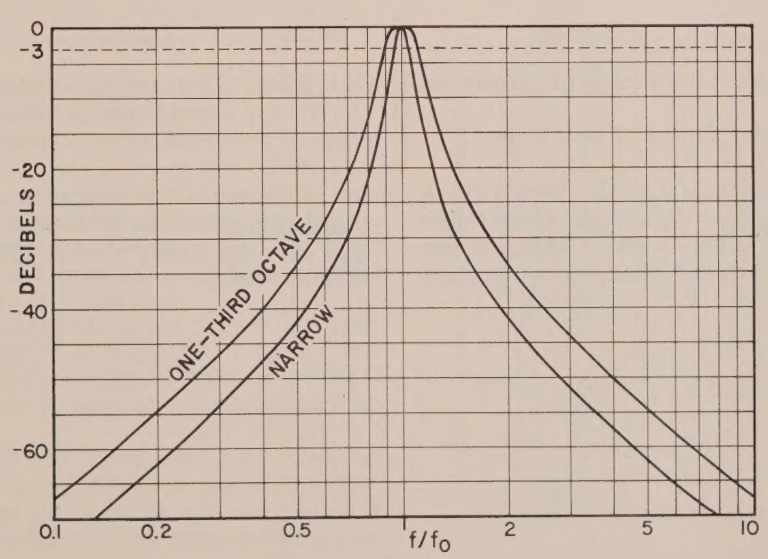


Figure 2. Filter Response Characteristics for ONE-THIRD OCTAVE and NARROW Bands

1.2.2 CONTROLS. The following controls are on the panel of the Sound and Vibration Analyzer:

Name	Type	Function & Paragraph Ref
Power	5-position rotary switch	Turns power on, permits battery check and calibration with ac line (2.1).
Battery Check	5-position rotary switch	Selects battery to be checked (2.1).
VOLTS FULL SCALE	6-position rotary switch	Operates main attenuator (2.2).
INPUT ATTENUATOR	5-position rotary switch (coaxial with VOLTS FULL SCALE control)	Operates input attenuator (2.2).
DECIBELS	Movable dial plate, on INPUT ATTENUATOR control	Allows db scale to be arbitrarily positioned behind VOLTS FULL SCALE knob for calibration (2.3.2).
SLOW-FAST	Toggle switch	Selects slow or fast time-constant meter characteristics (2.2h).
CAL	Rotary thumbset button	Adjusts gain for calibration (2.3.2).
BANDWIDTH	3-position rotary switch	Selects desired filter characteristic (2.2).
FREQUENCY	Continuous rotary control and dial	Adjusts center frequency of filter (2.3.1).
FREQUENCY MULTIPLIER	4-position rotary switch	Selects operating range of FREQUENCY control

1.2.3 CONNECTORS. The following connectors are on the panel of the Sound and Vibration Analyzer:

Name	Type	Function
INPUT	Phone jack	Signal input to instrument
OUTPUT	Phone jack	Output of instrument
CAL INPUT	2-terminal male connector	Connection to 115 v ac for calibration of input voltage

1.3 ACCESSORIES. Supplied with the Type 1554-A Sound and Vibration Analyzer are a Type 760-38 Cable Assembly, a Type CAP-11 Calibrating Cable, a phone plug, an accessories pouch and chain, and a complete set of batteries. A copy of the Handbook of Noise Measurement is also included. An airplane-luggage-type carrying case (Part No. 1554-P1) is available on special order.

Section 2

OPERATING PROCEDURE

2.1 TO TURN ON AND CHECK BATTERIES.

a. Turn the VOLTS FULL SCALE knob fully clockwise, and snap the SLOW-FAST switch to FAST.

b. Turn the power switch to BAT CHECK. (When this knob is moved from its OFF position, a red marker is visible as a reminder that the instrument is on.)

c. To check the condition of all five batteries, turn the battery check switch to B-1, B-2, B-3, B-4, and B-5. At each position the meter should deflect to the right of the red line marked B. If at any position it does not, replace the appropriate battery (refer to Parts List for replacements).

d. If all batteries are good, turn the power switch to ON, and allow about 30 seconds warmup time.

2.2 TO APPLY AN INPUT SIGNAL.

a. Turn the BANDWIDTH switch to ALL-PASS, and turn the VOLTS FULL SCALE switch fully clockwise.

b. Turn the INPUT ATTENUATOR dial fully counterclockwise. (Remember that the Analyzer is not designed to handle inputs over 30 volts.)

c. Connect the signal source to the INPUT jack, using a phone plug.

WARNING

The input is unbalanced, with the low side permanently grounded to the case

d. If, after connection of the input signal, the meter indicates far down scale, turn the INPUT ATTENUATOR dial clockwise until the meter indication is between 0 and +10 db on the top scale. If the signal causes the meter to indicate off scale at the high end, turn the CAL thumb control counterclockwise. If this does not bring the meter on scale, the input signal amplitude is too large, and must be attenuated before it is applied to the Analyzer.

e. If the amplitude of the input signal is known beforehand, set the INPUT ATTENUATOR dial so that the number adjacent to the INPUT VOLTS SHOULD NOT EXCEED marker is equal to or greater than the input signal voltage.

f. After the BANDWIDTH switch is set to either ONE-THIRD OCTAVE or NARROW, the INPUT ATTENUATOR dial must not again be moved because of the possibility of overloading the input circuit, with consequent distortion of the signal. All subsequent adjustments of gain must be made with the VOLTS FULL SCALE knob.

g. Select the center frequency of the analysis band by turning the FREQUENCY dial. Dots mark the ASA preferred 1/3-octave band center frequencies for acoustical measurements 10, 12.5, 16, 20, 25, 31.5 40, 50, 63, 80, 100, 125, 160, 200 cps, etc).

h. For convenience in reading the meter on the lowest (x1) range, the toggle switch below the meter, when at SLOW, connects a capacitor across the meter. Normally, on all ranges other than the lowest, the FAST meter response should be used.

2.3 ANALYSIS OF SOUND.

2.3.1 GENERAL. The Type 1554-A Sound and Vibration Analyzer can be used in conjunction with a Sound-Level Meter for the frequency analysis of sounds. Its one-third-octave filter characteristic allows a rapid determination of the spectral characteristics of sound in detail adequate for many purposes. The American Standards Association preferred center frequencies for one-third-octave bands are marked on the FREQUENCY dial to facilitate adjustment from one band to the next. Such data may be plotted directly on Codex No. 31462 Graph Paper (Codex Book Co., Inc., Norwood, Mass.). A plot of noise from a calculating machine is shown in Figure 3. In addition to the flat-topped one-third-octave filter

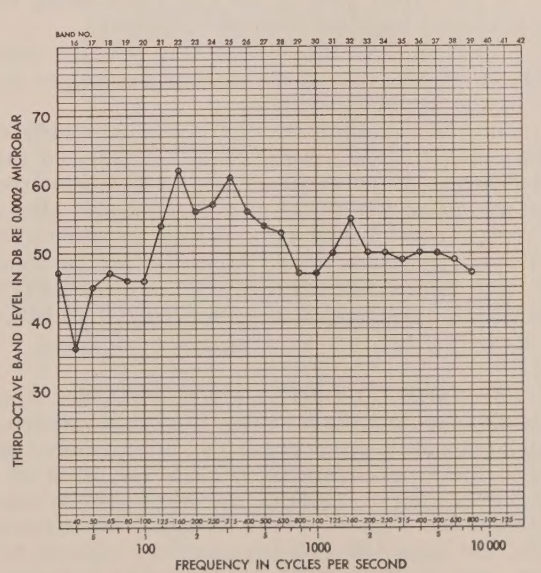


Figure 3. Plot of 1/3-Octave-Band Analysis of Noise from Calculating Machine

characteristic, there is a narrower filter bandwidth with a peaked shape, useful for the identification and measurement of line (single-frequency) spectral components. The Type 1554-A is easily calibrated to be direct-reading in one-third-octave sound pressure level or in component sound pressure level.

When the sound pressure is great enough (refer to Table 1), the use of a sound-level meter is unnecessary, and a microphone having a low-impedance output can be connected directly to the input of the Sound and Vibration Analyzer. For such use the system can be calibrated to be direct-reading in sound pressure level by means of a sound-level meter calibrator such as the Type 1552-B.

2.3.2 PROCEDURE. The following instructions apply specifically to the Type 1551 Sound-Level Meter. For most sound-level meters the procedure will be similar.

a. Calibrate the Sound-Level Meter by means of its internal calibration system or by means of the Type 1552-B Sound-Level Calibrator.

b. Turn the WEIGHTING switch on the Sound-Level Meter to C, and, with the sound to be analyzed applied to the input, turn the attenuator for a meter indication between 0 and 10 db. (If it is more convenient, the signal from a Type 1552-B Sound-Level Calibrator may be used at this point.) Set the meter response as desired (refer to paragraph 2.2h).

c. Turn the VOLTS FULL SCALE knob on the Analyzer fully clockwise, and set the INPUT ATTENUATOR dial so that 1 is at the INPUT VOLTS SHOULD NOT EXCEED marker.

d. Connect the OUTPUT jack of the Sound-Level Meter to the INPUT jack of the Analyzer, using the cable assembly supplied with the Analyzer.

e. Adjust the CAL thumb control to give the same reading on the db scale of the Analyzer meter as appears on the Sound-Level Meter.

f. Turn the movable DECIBELS dial, mounted on the front of the INPUT ATTENUATOR dial, so that the knob points to the same number as that appearing at the attenuator window on the Sound-Level Meter. The Analyzer is now direct-reading in one-third-octave sound pressure level. After making the above calibration, do not readjust the INPUT ATTENUATOR or the movable DECIBELS dial; use the VOLTS FULL SCALE control for further adjustments of gain.

2.3.3 USE DIRECTLY WITH MICROPHONE. When the one-third-octave-band levels in a sound spectrum are high enough, a microphone can be connected directly to the Analyzer input, without the need of a Sound-Level Meter. Suitable microphones for such use include the Type 1560-P12 Dynamic Microphone System, the Type 759-P25 Dynamic Microphone Assembly, and the Type 1551-P1L and 1551-P1H Condenser Microphone Assemblies. A 100-foot extension cable is available for use with the Dynamic Microphone Assembly, so that the microphone can be used away from the Analyzer.

The Type 1551-P1L Condenser Microphone Assembly uses the Altec Type 21-BR-150 condenser microphone, useful at sound pressure levels up to 150 db. The Type 1551-P1H Assembly uses the Altec Type 21-BR-180 microphone, useful up to 170 db. Both assemblies have good frequency response from 20 to 18,000 cycles per second.

Table 1 gives the most convenient setting of the DECIBELS dial with respect to the INPUT ATTENUATOR dial, the maximum sound pressure level at which the microphone should be used, and the smallest readable component or one-third-octave band level for each of the above-described microphones.

TABLE 1

Microphone Type	DECIBELS dial set opposite 1 volt	Max sound pressure level	Smallest readable component level
1560-P12 (with transformer)	120 db	140 db	50 db
759-P25 (with transformer)	120 db	140 db	50 db
1551-P1L	120 db	155 db	50 db
1551-P1H	130 db	170 db	60 db

To calibrate the microphone-Analyzer system, set the movable DECIBELS dial with respect to the INPUT ATTENUATOR dial as specified in Table 1. Place the Type 1552-B Sound-Level Calibrator over the microphone and adjust the INPUT ATTENUATOR dial and the CAL thumb control until the sum of the VOLTS FULL SCALE switch setting and the meter indication in decibels equals the sound pressure the Calibrator generates when used with that microphone (refer to the Calibrator Operating Instructions). As long as the DECIBELS dial is not moved with respect to the INPUT ATTENUATOR dial, the system will indicate sound pressure level directly in decibels.

When the microphone is placed in the sound field to be analyzed, turn the BANDWIDTH switch to ALL-PASS. Adjust the INPUT ATTENUATOR dial so that the meter indicates between 0 and 10 db. Use the VOLTS FULL SCALE switch for all subsequent gain adjustments.

2.4 ANALYSIS OF VIBRATION.

2.4.1 GENERAL. The Sound and Vibration Analyzer covers nearly the entire frequency range of interest in the measurement of vibration. When the Type 1554-A is used with a Vibration Meter, the linear scales on the Analyzer meter can be used to indicate

velocity, displacement, or acceleration. Such data can also be recorded in decibels.

2.4.2 PROCEDURE. The following instructions apply specifically to the Type 1553-A Vibration Meter. For other vibration meters the procedure should be similar.

a. To calibrate the Analyzer, set the BANDWIDTH switch to ALL-PASS, and set the INPUT ATTENUATOR dial so that the number 3 (volts) on the dial is at the INPUT VOLTS SHOULD NOT EXCEED marker.

b. Connect the OUT jack of the Vibration Meter to the INPUT jack of the Analyzer, using the cable assembly supplied with the Analyzer.

c. With the vibration pickup attached to the source of vibration, turn the SCALE SELECTOR knob on the Vibration Meter so that its meter reads as far upscale as possible (without going beyond full scale).

d. Adjust the CAL control so that the numerical indication on the appropriate Analyzer meter scale is the same as that on the Vibration Meter. The scales can then be used to indicate linear units such as microinches per second, and it is necessary only to keep track of decimal points as the VOLTS FULL SCALE knob is reset during analysis. It may be more convenient to record vibration frequency analysis in decibels relative to the over-all vibration level indicated by the Vibration Meter.

e. Set the meter response as desired (refer to paragraph 2.2h.)

2.5 ANALYSIS OF ELECTRICAL SIGNALS.

2.5.1 GENERAL. The Sound and Vibration Analyzer is very useful in the analysis of electrical signals not exceeding 30 volts. The ALL-PASS characteristic allows the entire input signal to be adjusted to full scale (100 percent) on the meter for measurement of percent harmonic distortion. The linear meter scales allow direct reading of component levels in percent. The NARROW bandwidth is selective enough to permit detection of as little as a one-percent second harmonic and a 0.2-percent third harmonic. The Analyzer can be internally calibrated by means of a 115-volt ac line to be direct-reading in terms of input voltage.

As a tuned detector for bridge balance the Analyzer provides 40 db discrimination against the second harmonic and 54 db against the third, and, being battery-powered, is entirely hum-free. Its most sensitive range is 1 mv full scale, and it can therefore be used to balance down to 50 microvolts, if harmonic distortion is not excessive.

The Analyzer is especially useful in determining the spectrum of noise, particularly at low frequencies. The one-third-octave pass band allows much easier measurement of noise than can be achieved by narrower-band constant-percentage analyzers, because the meter fluctuation is inversely proportional to filter bandwidth. Figure 4 shows the spectrum of the output of a Type 1390-B Random-Noise Generator. Since the Analyzer bandwidth is proportional to the center frequency, white noise appears to have a slope of +3 db per octave. Deviations from whiteness can easily be detected, however, by comparison with a straight line having a 3-db per-octave slope.

2.5.2 PROCEDURE. The Analyzer can be calibrated to be direct-reading in input voltage as follows:

WARNING

Before calibrating, remove all electrical connections from the Analyzer to other instruments or to ground.

a. Connect the CAL INPUT 115 v ac connector to a 115-volt ac line, using the cable supplied with the Analyzer.

b. Set the BANDWIDTH switch to ALL-PASS, turn the power switch to CAL READ, and note the indication of the meter. Set the meter response as desired (refer to paragraph 2.2h.)

c. Turn the power switch to CAL SET, and turn the CAL thumb control until the meter gives the indication noted in step b. The Analyzer is now direct-reading in terms of voltage at the INPUT jack. When applying a signal of unknown amplitude, follow the procedure described in paragraph 2.2.

2.6 USE WITH GRAPHIC LEVEL RECORDER.

2.6.1 GENERAL. The usefulness of the Type 1554-A Sound and Vibration Analyzer is greatly increased by use of the Type 1521-A Graphic Level Recorder to record the output as a function of frequency. A link unit (Type 1521-P11) connects the recorder to the FREQUENCY dial of the Analyzer so that the frequency scale on the chart paper (Type CTP-554) for

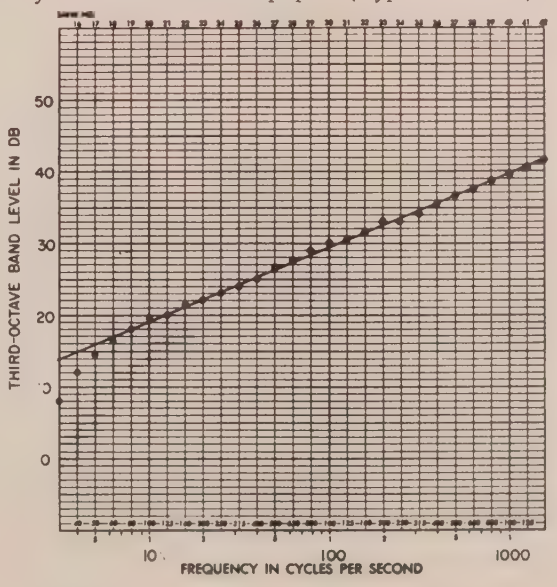


Figure 4. Spectrum of Output from Type 1390-B Random-Noise Generator

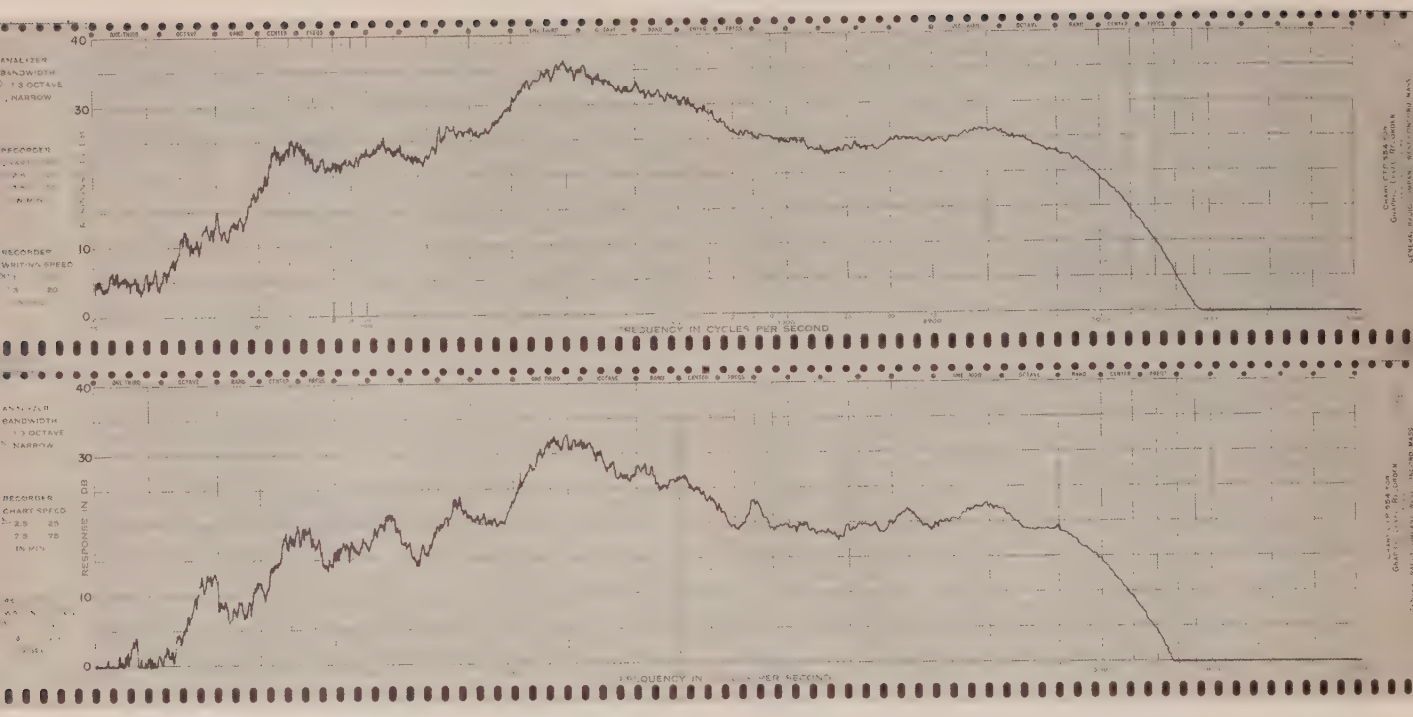


Figure 5a. Loudspeaker Response as Measured with Pink Noise and (top) One-Third-Octave Bandwidth on the Analyzer and (bottom) Narrow Bandwidth

this purpose exactly corresponds to the calibration of the FREQUENCY dial.

Because the recorder is not designed for use below 20 cycles per second, the chart paper covers only the upper three ranges of the Analyzer, from 25 to 25,000 cycles per second. Over this frequency range, the Recorder-Analyzer combination will produce continuous records of one-third-octave spectrum level, or, by use of the NARROW bandwidth, significantly more spectrum detail.

It has been customary in certain frequency-response measurements to use a "warble tone" (a sine-wave signal frequency-modulated over a wide range at a low frequency) to smooth the data obtained. A newer technique uses random noise and a constant-percentage-bandwidth filter. It is convenient first to correct for the 3-db-per-octave slope of white noise by means of a simple filter at the output of the noise generator.[1] Noise that has been thus converted from constant energy per cycle to constant energy per octave has been called "pink noise".[2]

In a loudspeaker response measurement (Figure 5a), for instance, it is convenient to "pinken" the noise before it is applied to the speaker; a flat response would then appear as level on the chart. In Figure 5a the fluctuation of the recorder trace decreases steadily from left to right, almost disappearing at the high-frequency end of the chart, as the filter bandwidth constantly widens.

2.6.2 PROCEDURE. (To use the Type 1554-A Sound and Vibration Analyzer with the Type 1521-A Graphic

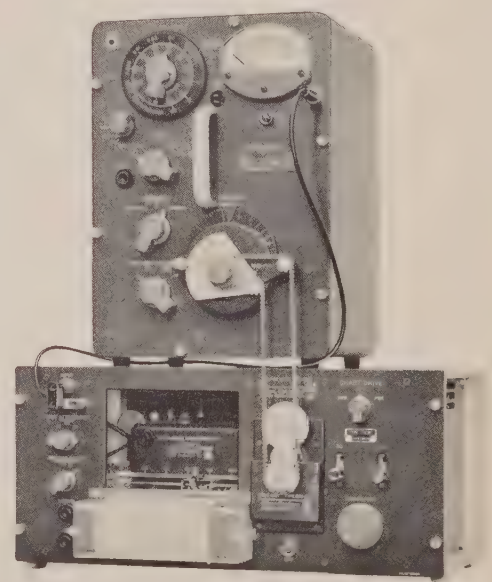


Figure 5b. Type 1554-A Sound and Vibration Analyzer Connected to Type 1521-A Graphic Level Recorder.

[1] Such a filter is available as the Type 1390-P2 Pink-Noise Filter.

[2] C.G. Mayo and D.G. Beadle, "Equipment for Acoustic Measurements (Part 4), ELECTRONIC ENGINEERING, Vol 23, pp 462-465, December 1951.

Level Recorder, refer also to the Recorder Operating Instructions.) The Type 1521-A Graphic Level Recorder and the Type 1554-A Sound and Vibration Analyzer should be connected as shown in Figure 5b, by means of the Type 1521-P11 Link Unit. The Type 1560-P95 Accessory Cable supplied with the Recorder is used to connect the output of the Analyzer to the input of the Recorder.

Because the frequency response of the Recorder is flat down to only 20 cycles per second, the special chart paper, Type CTP-554, covers only the upper three frequency ranges of the Analyzer. To record over a span wider than one range, disconnect the chain-driven clutch at the upper end of each range, turn the Analyzer FREQUENCY dial back by hand, and advance the RANGE switch manually. For a better-looking recording, lift the pen off the chart paper while making these adjustments.

When the 80-db potentiometer is used with the Recorder, self-noise of the Analyzer may be visible at the bottom of the chart, in the absence of signal. To minimize this noise, adjust the signal at the Analyzer to be as close as possible to full scale when the BANDWIDTH switch is at ALL-PASS.

2.7 USE AS NARROW-BAND NOISE GENERATOR. In some acoustical measurements, such as of decay characteristics of a room or auditorium, it is desirable to use a narrow band of noise. The Type 1554-A Sound and Vibration Analyzer can be used as a one-third-octave-band filter following a random-noise generator for such purposes. The maximum output level of the Analyzer is 1 volt rms from a source impedance of 5000 ohms.

2.8 SPECTRAL DENSITY LEVEL. Spectral density level, a measure of the noise energy contained within a band one cycle per second wide, can be determined by means of the Type 1554-A. However, because the bandwidth of the analyzer increases in cycles directly with the mean frequency of the band, a noise signal whose spectral density level is uniform over the frequency range will give higher-level readings as the analyzer mean frequency increases. A correction is therefore required, and the graph of Figure 6 shows the number of db that must be subtracted from the analyzer reading to convert to spectral density level.

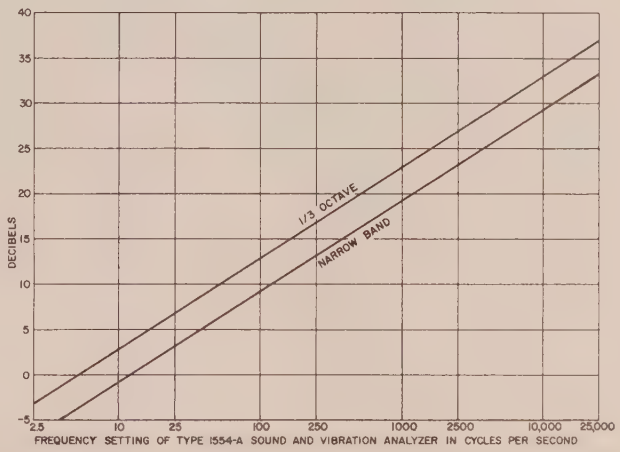


Figure 6. Plots showing number of db to be subtracted from analyzer reading to convert to spectral density level.

Section 3

PRINCIPLES OF OPERATION

3.1 GENERAL. The Type 1554-A Sound and Vibration Analyzer is basically a tuned voltmeter with a constant-percentage bandwidth. Two frequency-selective circuits employing Wien-bridge feedback networks are connected in cascade, and tuning is either staggered to produce a one-third-octave bandwidth or synchronous for a narrower response band. The functional block diagram (Figure 7) shows the two tuning units, the input and output amplifier, the input attenuator, and the main attenuator. The main attenuator is split into three different sections, so that each successive step of attenuation can be inserted

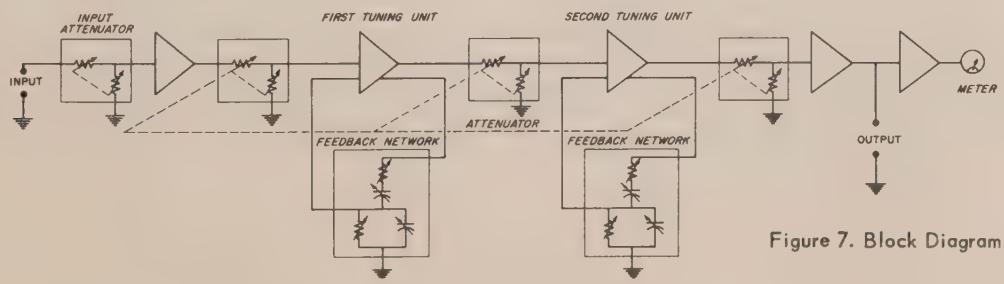


Figure 7. Block Diagram of Analyzer

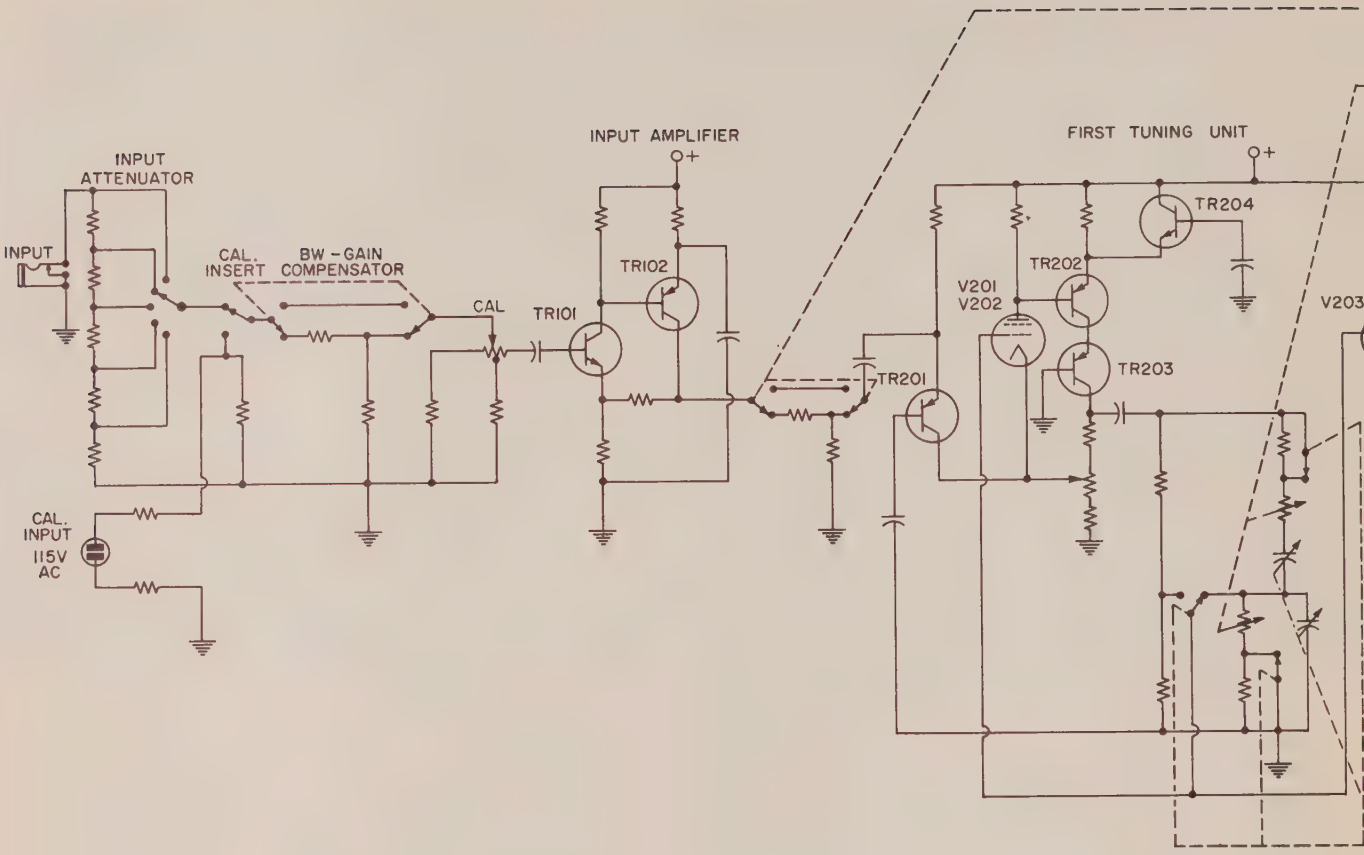
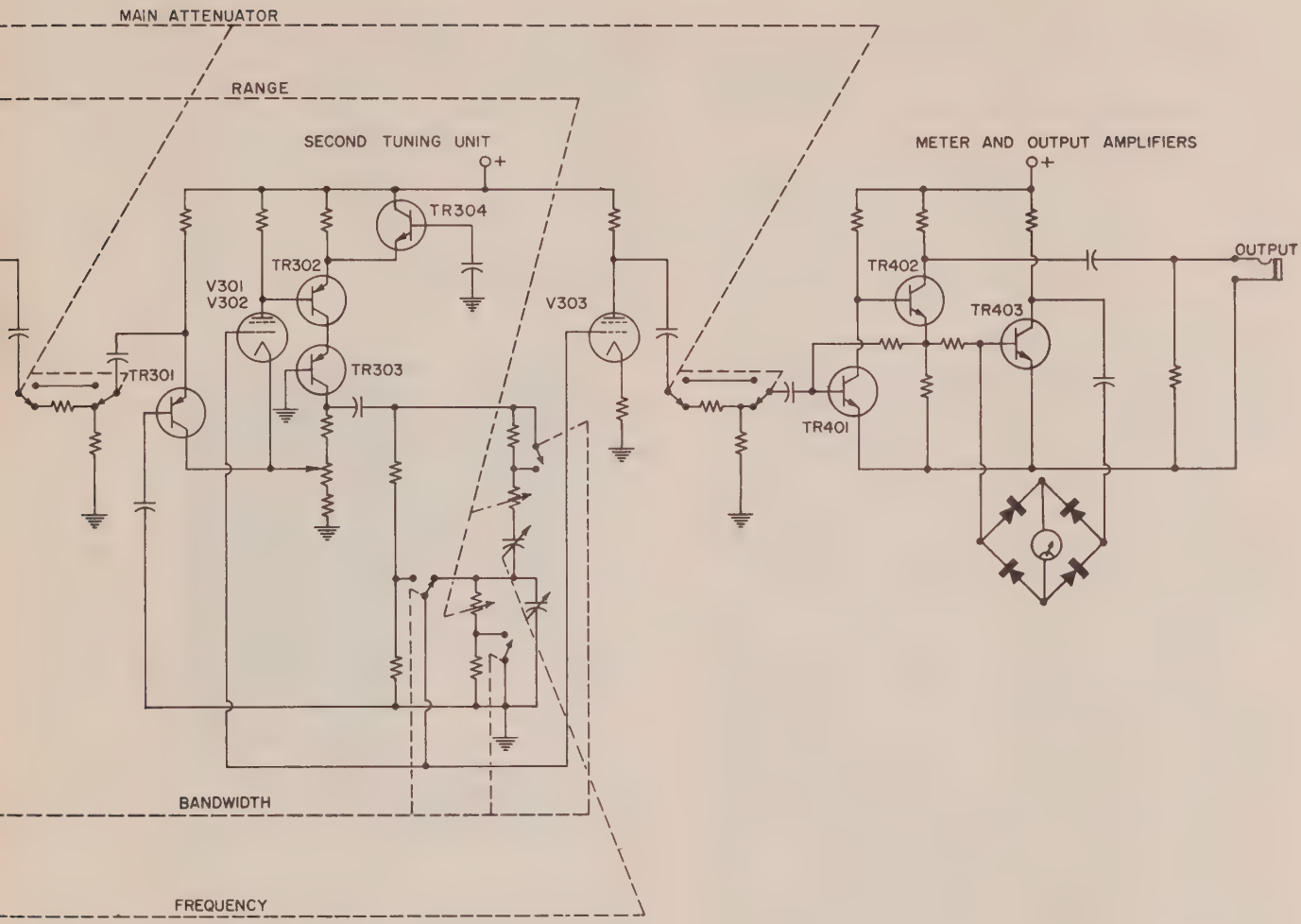


Figure 8. Elem

where it will achieve the greatest possible signal-to-noise ratio, and give the best protection against overloading.

3.2 CIRCUIT DESCRIPTION. (Refer to Figure 8). Immediately following the input attenuator is the point where a 115-volt ac signal can be inserted for calibration (refer to paragraph 2.5.2). The bandwidth-gain compensator is an attenuator switched by the BANDWIDTH control to adjust for the difference in gain between synchronous and stagger-tuned operation. The CAL control is a continuously variable attenuator with a range of 12 db. The input amplifier is a two-transistor feedback circuit having the correct input impedance to terminate the input attenuator system properly.

The first tuning unit includes TR202, TR203, TR204, V201, V202, and V203. (V201 and V202 are connected in parallel.) The tuning unit is basically an amplifier consisting of V201-V202 and TR202, which has a negative feedback path to the filament of the tubes and a choice between two positive feedback paths to the grids. TR201 is used simply to inject the input signal current from a high source impedance. TR203, in cascode with TR202, protects TR202 from harmful effects of collector-to-base feedback. TR204 is an active circuit replacing the usual emitter bypass capacitor for TR202. Because



Schematic Diagram

of the very low frequency range of this instrument, this bypass capacitor would have to be so large that it would require an inordinate length of time to charge and for the circuit to reach equilibrium. The use of TR204 has very materially contributed to the short warmup time of the Type 1554-A.

One of the positive feedback paths is of the Wien-bridge type, which produces a maximum feedback at one frequency and makes the tuning unit frequency-selective. The other feedback path is a resistive voltage divider, which produces the nonselective or all-pass response. V203 amplifies the output from the Wien-bridge network for the input of the next tuning unit. The two tuning units are identical except that, for the one-third-octave characteristic, one is staggered upwards and the other downwards.

In the output circuits, another feedback pair (TR401 and TR202) drives current into TR403 for the meter and provides the output signal voltage. TR403 operates with full current feedback to drive an accurate replica of its input current through the meter-rectifier circuit, producing a highly accurate measure of the average value of the input signal.

The voltage regulator circuit includes a voltage reference diode, D5, connected to transistor TR1, which operates as an emitter follower to supply a constant 39 volts to the Analyzer circuits. Transistor TR2 supplies a constant current to the reference diode independently of battery voltage.

Section 4

SERVICE AND MAINTENANCE

4.1 GENERAL. The two-year warranty given with every General Radio instrument attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible.

In case of difficulties that cannot be eliminated by the use of these service instructions, please write or phone our Service Department, giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest district office (see back cover), requesting a Returned Material Tag. Use of this tag will insure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

4.2 REPLACEMENT OF BATTERIES. Before using the Analyzer, check all batteries as outlined in paragraph 2.1. If any battery is defective, it must be replaced to insure proper operation of the Analyzer. It is not necessary to remove the instrument from its case in order to replace a battery.

To gain access to the battery compartment, set the Analyzer up with the panel vertical, and pull open the battery access door (see Figure 9). B1 is a pair of 67.5-volt batteries in parallel, under the black bakelite cover. To open the cover, push the spring release to the right. Replace these batteries with Eveready No. 467, Burgess XX45, or equivalent. Observe the polarity indicated on the top of the cover and on the inside of the battery access door when inserting the new batteries.

B 2, B 3, B 4, and B 5 are located in cans with twist-lock-caps. To remove any of these batteries, turn the cap counterclockwise until it is loose, and the battery will spring up so that it can be gripped with the fingers. Replace any of these batteries with Eveready No. 935C Cell, Rayovac No. 1LP, or equivalent. Observe polarity; the positive terminal of the battery should be up. Then snap the battery access door shut.

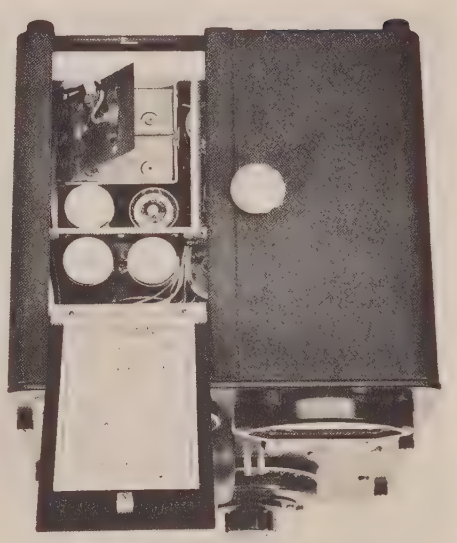


Figure 9. Top View, Showing Battery Compartment

4.3 ROUTINE MAINTENANCE. The simple tests described below can be made periodically to determine whether the Analyzer is operating properly. Equipment required is an oscillator with an output of 1 volt from 25 to 25,000 cps, and a vacuum-tube voltmeter to monitor the amplitude.

a. Turn the INPUT ATTENUATOR dial so that the 1 (volt) marking is adjacent to the INPUT VOLTS SHOULD NOT EXCEED marker on the panel.

b. Set the BANDWIDTH switch to ALL-PASS.

c. Apply an input signal of 1 volt at 25 cps and adjust the CAL control for a +8 db indication on the top meter scale.

d. Change the input frequency to 25,000 cps without changing the amplitude. The meter indication should be between +6 and +10 db.

e. Change the input signal frequency back to 25 cps.

f. With the RANGE switch at x1 and the FREQUENCY dial at 25, set the switch to ONE-THIRD OCTAVE. The meter indication should be between +6 and +10 db.

g. Set the BANDWIDTH switch to NARROW. The meter indication should remain between +6 and 10 db.

h. Repeat steps f and g, keeping the input-signal amplitude constant, at 250, 2500, and 25,000 cps, turning the RANGE switch to x10, x100 and x1000, respectively. At each frequency, for all three positions of the BANDWIDTH switch, the meter indication should be between +6 and +10 db.

i. Set the RANGE switch to x100 and the oscillator frequency to 500 cps. Turn the FREQUENCY dial to 2.5 and the BANDWIDTH switch to ALL-PASS.

j. Adjust the CAL control so that the meter indicates +8db on the top scale. Then set the BANDWIDTH switch to NARROW and set the VOLTS FULL SCALE knob to 0.01. The meter should not indicate more than +8 on the top scale.

4.4 TO REMOVE INSTRUMENT FROM ITS CASE. To remove the Analyzer from its case, first position it so that the panel is horizontal. Then remove the six thumb screws at the edges of the panel, and carefully lift the Analyzer straight up and out of the case.

4.5 TUBE REPLACEMENT. As tubes age, filaments may become open-circuited. Check the filament resistance with an ohmmeter between pins 3 and 5 of the tube base (see Figure 14). Make sure that the ohmmeter current through the filaments is less than 10 ma.

When replacing a tube, cut the leads on the new tube to between 5/16 and 3/8 inch before inserting the tube in the socket. Install the tube so that the red dot on the tube base is adjacent to the red mark on the socket.

No realignment is necessary after replacement of V203 or V303. After replacing V201, V202, V301, or V302, make the routine checks described in paragraph 4.3 to determine whether realignment is necessary.

4.6 TRANSISTOR REPLACEMENT. If any transistor is suspected of improper operation, remove it from the Analyzer and test it with a transistor beta tester. Measure the short-circuit current gain from base to collector at 6 volts collector bias and 1 ma emitter current. The current gain (h_{fe}) should be between 50 and 220 for each transistor used in this instrument.

If any transistor other than TR202, TR302, TR203, and TR303 is inoperative, replace it with another of the same type. Before inserting the new transistor in the socket, cut its leads to between 3/8 and 1/2 inch. Insert the transistor so that the collector is adjacent to the red mark on the socket (see Figure 14).

If either TR203 or TR303 is inoperative, replace it with another transistor of the same type, and make the routine checks described in paragraph 4.3 to determine whether realignment is necessary.

TR202 and TR302 are specially selected transistors with current gains (h_{fe}) greater than 125. If either is inoperative and must be replaced, the Analyzer will probably have to be realigned.

4.7 REALIGNMENT PROCEDURE

4.7.1 GENERAL. Instruments required to realign the Analyzer are a sensitive ac voltmeter, oscillators covering the frequency range from 2.5 to 100,000 cps, and equipment for standardizing frequencies of 2.5, 25, 250, 2500, and 25,000 cps.

The procedure is first to adjust the ALL-PASS response of each tuning unit so that it is flat up to 25,000 cps, and then to adjust the NARROW response of each tuning unit so that the peak response occurs at the proper frequency and is of the same amplitude as the ALL-PASS response. The ONE-THIRD OCTAVE characteristic is thus automatically aligned, and no further adjustments for ONE-THIRD OCTAVE are necessary.

4.7.2 ALL-PASS ADJUSTMENT OF FIRST TUNING UNIT. The first tuning unit is at the rear of the instrument behind the center panel. All its screwdriver adjustments are behind the center panel.

a. Unsolder the jumpers between TP1 and TP2, between TP3 and TP4, and between TP5 and TP6 (see Figure 11).

b. Temporarily connect TP1 to TP2 and TP3 to TP6.

c. Turn the Analyzer on and check the batteries. It is best to use new batteries for alignment.

d. Apply a signal of 1 volt at 250 cps to the INPUT jack.

e. Turn the INPUT ATTENUATOR dial so that 1 is adjacent to the INPUT VOLTS SHOULD NOT EXCEED marker, and turn the VOLTS FULL SCALE knob fully clockwise.

f. Turn the BANDWIDTH switch to ALL-PASS.

g. Temporarily connect TP7 to TP8 (Figure 10).

h. Connect a sensitive ac voltmeter between TP11 and ground (chassis). Adjust the CAL control so that the voltmeter indicates 0.045 volt.

i. Remove the connection between TP7 and TP8, and adjust R211 so that the voltmeter indicates 1 volt at TP11. Repeat steps h and i if necessary.

j. Adjust the CAL control so that the Analyzer meter indicates +8 on the DECIBELS scale.

k. Change the input frequency to 25,000 cps. Keep the input amplitude constant, using the voltmeter to check.

l. Adjust C250 (Figure 10) so that the panel meter again indicates +8 db.

The frequency response should now be flat up to 25,000 cps. If it humps more than 1 db below 25,000 cps, adjust C205 (Figure 11) to decrease its capacitance, and readjust C250 as described above. If it humps above 25,000 cps, adjust C205 to increase its capacitance, and readjust C250. With a satisfactory

adjustment, the -3db point will occur between 40,000 and 70,000 cps.

4.7.3 ALL-PASS ADJUSTMENT OF SECOND TUNING UNIT. The second tuning unit and all its adjustments are between the front panel and the center panel.

a. Temporarily connect TP1 to TP2, TP3 to TP4, and TP5 to TP6.

b. With controls set as in steps e and f, paragraph 4.7.2, apply a signal of 1 volt at 250 cps to the INPUT jack.

c. Temporarily connect TP9 to TP10 (Figure 10).

d. Connect the ac voltmeter between TP12 and ground, and adjust the CAL control so that the meter indicates 0.045 volt at TP12.

e. Remove the connection between TP9 and TP10 and adjust R311 (Figure 11) so that the voltmeter indicates 1 volt at TP12.

f. Adjust the CAL control so that the panel meter indicates +8 on the DECIBELS scale.

g. Change the input frequency to 25,000 cps. Keep the input amplitude constant, using the voltmeter to check.

h. Adjust C350 (Figure 10) so that the panel meter again indicates +8 db.

The frequency response should now be flat up to 25,000 cps. If it humps appreciably below 25,000 cps, adjust C305 to decrease its capacitance, and readjust C350 as described above. If it humps above 25,000 cps, adjust C305 to increase its capacitance, and readjust C350. With a satisfactory adjustment, the -3 db point (+5 db on the meter in this instance) occurs between 30,000 and 60,000 cps.

4.7.4 NARROW-BAND ADJUSTMENT OF FIRST TUNING UNIT. The narrow-band alignment of the first tuning unit is made by comparison of the amplitude of response with that of the all-pass response, which has already been aligned. All adjustments on the first tuning unit are at the rear of the instrument, behind the center panel.

a. Temporarily connect TP1 to TP2 and TP3 to TP6.

b. Apply a signal of 1 volt at 2.5 cps to the INPUT jack. This frequency and those used in subsequent procedures must be standardized to better than ±1% accuracy.

c. Set the BANDWIDTH switch to ALL-PASS, and adjust the CAL control for an indication of 8 db on the panel meter. At this low frequency, the meter is easier to read if the SLOW-FAST switch is at SLOW.

d. Set the BANDWIDTH switch to NARROW.

e. Adjust R252 (LO x 1; see Figure 10) so that the panel meter indicates +8 db.

f. Turn the Analyzer FREQUENCY dial to determine where the peak response occurs. If it occurs at a frequency lower than 2.5 cps, turn R264 (HI x 1; Figure 10) counterclockwise, and readjust R252 for the +8 db meter indication. If it occurs at a frequency higher than 2.5 cps, turn R264 clockwise and readjust R252 as above.

g. Change the input signal frequency to 25 cps ±1%.

h. Set the BANDWIDTH switch to ALL-PASS, and adjust the CAL control so that the meter indicates +8 db.

i. Set the BANDWIDTH switch to NARROW, and turn the FREQUENCY dial to 25.

j. Adjust C258 (LO x 1; Figure 12) so that the meter again indicates +8 db.

k. Turn the Analyzer FREQUENCY dial to determine where the peak response occurs. If it occurs at a dial indication less than 25, turn C259 to increase capacitance and readjust C258 for the +8 db meter indication. If it occurs at a frequency higher than 25 cps, turn C259 to decrease capacitance and readjust C258 for the +8 db meter indication.

l. It may be necessary to return to 2.5 cps and to readjust the low-frequency end of the dial, if the misalignment was great. This procedure must be repeated for the other three frequency ranges of the first tuning unit; instructions are summarized in the table below.

TABLE OF ADJUSTMENTS
FIRST TUNING UNIT

STANDARDIZED TEST FREQUENCY	FREQUENCY DIAL	FREQUENCY MULTIPLIER	ADJUST FOR LEVEL	ADJUST FOR FREQUENCY CAL (THEN AGAIN)
2.5	2.5	1	R252 (LOW X1)	R264 (HIGH X1)
25	25	1	C258 (LOW X1)	C259 (HIGH X1)
25	2.5	10	R253 (LOW X10)	R265 (HIGH X10)
250	25	10	C256 (LOW X10)	C257 (HIGH X10)
250	2.5	100	R254 (LOW X100)	R266 (HIGH X100)
2500	25	100	C254 (LOW X100)	C255 (HIGH X100)
2500	2.5	1000	R255 (LOW X1000)	R267 (HIGH X1000)
25000	25	1000	C252 (LOW X1000)	C253 (HIGH X1000)

4.7.5 NARROW-BAND ADJUSTMENT OF SECOND TUNING UNIT. The procedure for narrow-band alignment of the second tuning unit is similar to that given in paragraph 4.7.4, except that, in step a, TP1 is connected to TP4 and TP5 to TP6. All adjustments of the second tuning unit are between the front panel and the center panel. Instructions are summarized in the table below.

4.7.6 ONE-THIRD-OCTAVE RESPONSE. When the above realignment procedure has been completed, the one-third-octave response will be automatically aligned properly. To check the one-third-octave response, proceed as follows:

a. Resolder the jumpers between TP1 and TP2, TP3 and TP4, and TP5 and TP6.

b. Set the BANDWIDTH switch to ALL-PASS.

c. Apply a signal of 1 volt at 10 cps to the INPUT jack, and adjust the CAL control for a meter indication of +8 db.

d. Set the BANDWIDTH switch to ONE-THIRD OCTAVE, set the FREQUENCY MULTIPLIER to 1, and set the FREQUENCY dial to 10. The meter should indicate between +6 and +10 db. To repeat this test at 100, 1000, and 10,000 cps, switch the FREQUENCY MULTIPLIER to 10, 100, and 1000 respectively.

4.8 EXTREMES OF TEMPERATURE AND HUMIDITY. The instrument should not be subjected to ambient temperature above 50°C (122°F). In relative humidity over 65 percent, the Analyzer may not function properly on the lowest range (RANGE switch at x1).

4.9 TEST VOLTAGES AND RESISTANCES. If the Analyzer is inoperative, replace all batteries and check the voltages at tube and transistor socket pins against those in Table 2. Such a check may help to isolate the trouble. Before replacing a tube or transistor, refer to paragraphs 4.5 and 4.6. If the tubes and transistors are all in good condition, check the resistances at socket pins (Table 2, page 18).

Before making voltage measurements, install new batteries, and turn the VOLTS FULL SCALE control fully counterclockwise. Turn the power switch ON and set the BANDWIDTH switch to ALL-PASS. Measure voltages with a 20,000-ohm-per-volt meter. Do not attempt to measure voltages at pins marked * in Table 2; the circuit impedance is too high.

Before making resistance measurements, remove all batteries, and short-circuit the B+ terminal at the B1 holder to ground. Remove all transistors from their sockets. Turn the power switch to ON and set the BANDWIDTH switch to ALL-PASS. Turn the INPUT ATTENUATOR dial fully counterclockwise and the VOLTS FULL SCALE knob fully clockwise. Remove the links between TP1 and TP2, TP3 and TP4, and TP5 and TP6. Check the resistances to ground with an ohmmeter.

TABLE OF ADJUSTMENTS
SECOND TUNING UNIT

STANDARDIZED TEST FREQUENCY	FREQUENCY DIAL	FREQUENCY MULTIPLIER	ADJUST FOR LEVEL	ADJUST FOR FREQUENCY CAL (THEN AGAIN)
2.5	2.5	1	R352 (LOW X1)	R364 (HIGH X1)
25	25	1	C358 (LOW X1)	C359 (HIGH X1)
25	2.5	10	R353 (LOW X10)	R365 (HIGH X10)
250	25	10	C356 (LOW X10)	C357 (HIGH X10)
250	2.5	100	R354 (LOW X100)	R366 (HIGH X100)
2500	25	100	C354 (LOW X100)	C355 (HIGH X100)
2500	2.5	1000	R355 (LOW X1000)	R367 (HIGH X1000)
25000	25	1000	C352 (LOW X1000)	C353 (HIGH X1000)

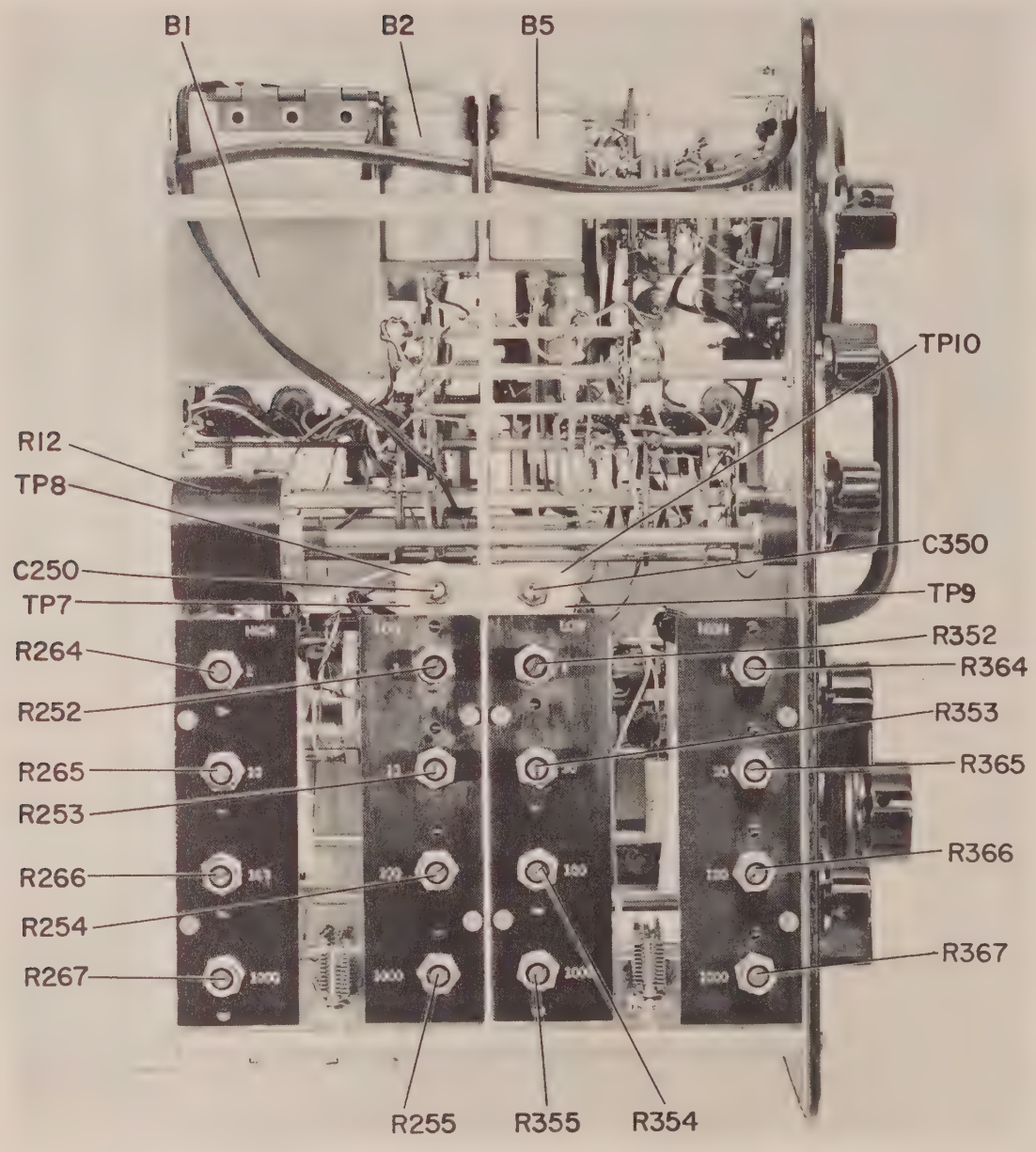


Figure 10. Left Side Interior View

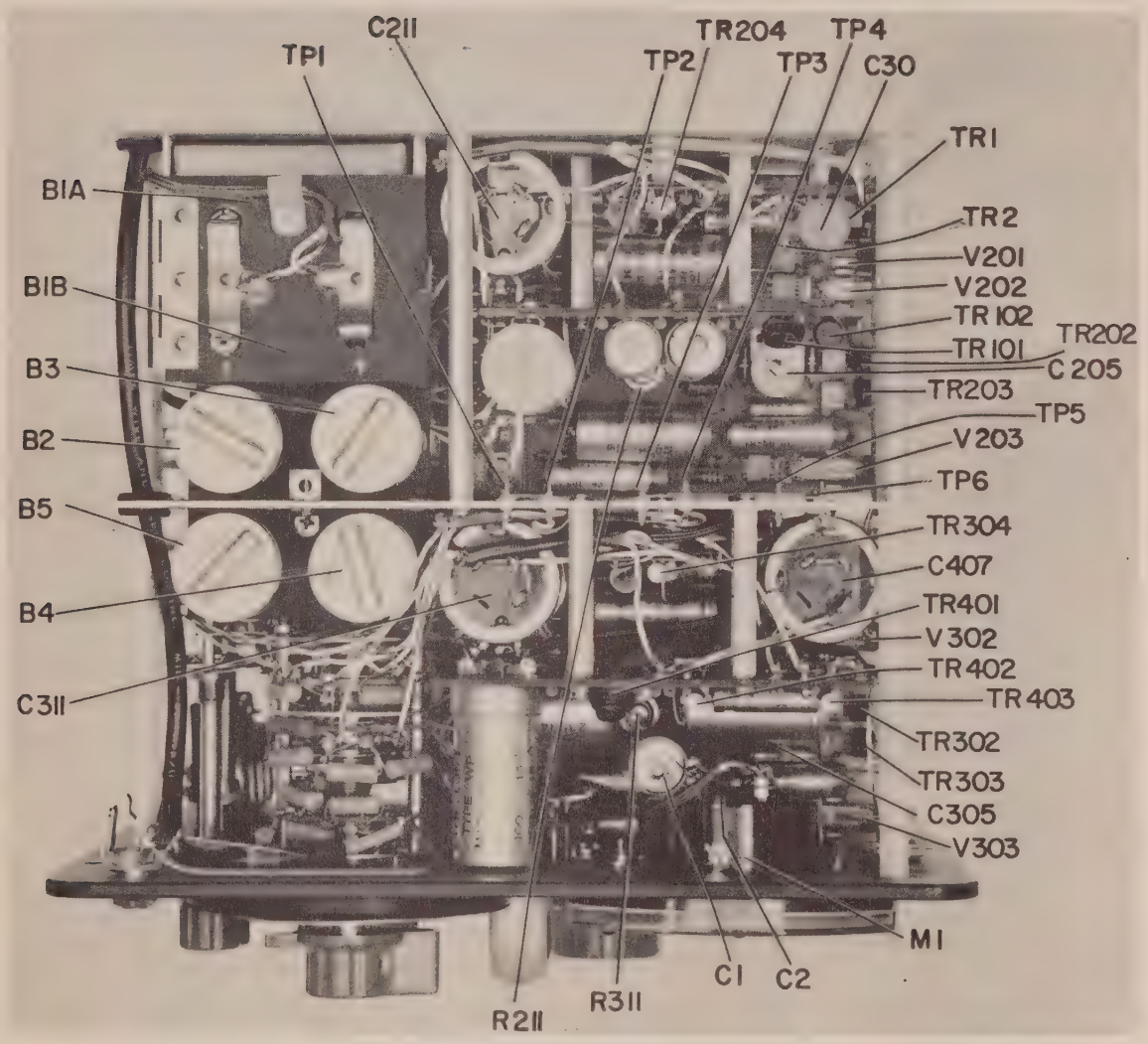


Figure 11. Top Interior View

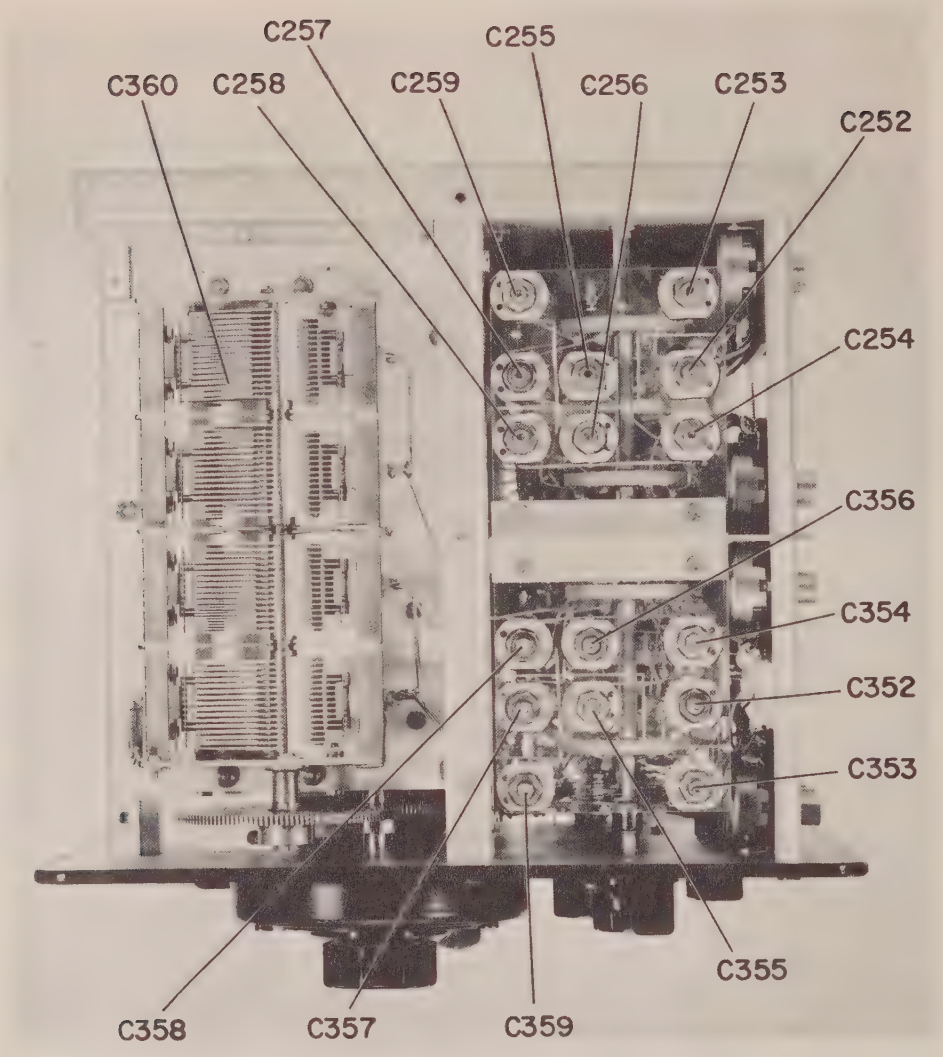


Figure 12. Bottom Interior View

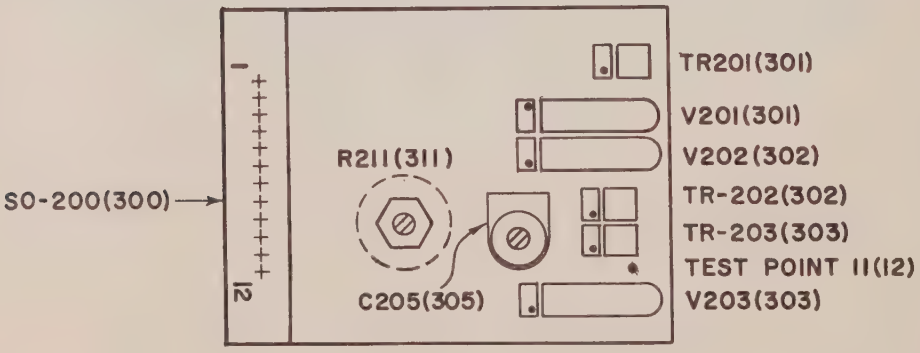


Figure 13. Amplifier Circuit Layouts. Components Numbered in 300 Series (and TP 12) are on Board Nearer Front Panel.

PARTS LIST

PART NO. (SEE NOTE)

RESISTORS. (k = kilohms, M = megohms)

R1	14.1k	±1%	1/4w	REF-65
R2	54.3k	±1%	1/4w	REF-65
R3	35.2k	±1%	1/4w	REF-65
R4	7.7k	±1%	1/4w	REF-65
R5	2.3k	±1%	1/4w	REF-65
R6	1.01k	±1%	1/4w	REF-65
R7	100k	±1%	1/4w	REF-65
R8	2.84k	±1%	1/4w	REF-65
R9	63.4k	±1%	1/4w	REF-65
R10	59k	±1%	1/4w	REF-65
R11	29.2k	±1%	1/4w	REF-65
R12	200k	±5%		0974-4000
R13	100k	±1%	1/4w	REF-65
R14	200k	±1%	1/4w	REF-65
R15	1.71k	±1%	1/4w	REF-65
R16	1.71k	±1%	1/4w	REF-65
R17	1.15k	±1%	1/4w	REF-65
R18	1.15k	±1%	1/4w	REF-65
R19	1.71k	±1%	1/4w	REF-65
R20	1.71k	±1%	1/4w	REF-65
R21	1.15k	±1%	1/4w	REF-65
R22	1.15k	±1%	1/4w	REF-65
R23	1.71k	±1%	1/4w	REF-65
R24	1.15k	±1%	1/4w	REF-65
R25	21k	±1%	1/4w	REF-65
R26	840k	±1%	1/4w	REF-65
R27	750k	±5%	1w	REF-30BF
R28	750k	±5%	1w	REF-30BF
R30	4.3k	±5%	1/2w	REC-20BF
R31	390k	±5%	1/2w	REC-20BF
R100	110k	±5%	1/2w	REC-20BF
R101	27k	±5%	1/2w	REC-20BF
R102	390k	±5%	1/2w	REC-20BF
R103	130k	±5%	1/2w	REC-20BF
R104	2k	±5%	1/2w	REC-20BF
R105	3.9k	±5%	1/2w	REC-20BF
R106	51k	±5%	1/2w	REC-20BF
R107	1k	±5%	1/2w	REC-20BF
R200	2.47k	±1%	1/4w	REF-65
R201	200k	±5%	1/2w	REC-20BF
R202	82k	±5%	1/2w	REC-20BF
R203	36k	±5%	1/2w	REC-20BF
R204	33k	±5%	1/2w	REC-20BF
R205	180k	±5%	1/2w	REC-20BF
R206	75k	±5%	1/2w	REC-20BF
R207	47k	±5%	1/2w	REC-20BF
R209	270k	±5%	1/2w	REC-20BF
R210	7.5k	±1%	1/3w	REPR-22
R211	1.0k	±10%		POSW-3
R212	3.6k	±1%	1/3w	REPR-22
R213	33k	±5%	1/2w	REC-20BF
R214	150k	±5%	1/2w	REC-20BF
R215	1.8k	±5%	1/2w	REC-20BF
R216	13k	±5%	1/2w	REC-20BF
R217	51k	±5%	1/2w	REC-20BF
R220	22k	±5%	1/2w	REC-20BF
R221	5.1k	±5%	1/2w	REC-20BF
R222	62k	±5%	1/2w	REC-20BF
R250	249k	±1%	1/2w	REF-70
R251	499k	±1%	1/2w	REF-70
R252	10M	±20%		POSC-11
R253	500k	±10%		POSC-11
R254	50k	±10%		POSC-11
R255	5k	±10%		POSC-11
R256	4.53M	±1%	1w	REF-3-2
R257	453k	±1%	1/4w	REF-65
R258	45.3k	±1%	1/4w	REF-65
R259	4.53k	±1%	1/4w	REF-65
R260	48.7M	±2%	2w	REF-3-3
R261	4.87M	±1%	1w	REF-3-2
R262	487k	±1%	1/4w	REF-65
R263	48.7k	±1%	1/4w	REF-65
R264	10M	±20%		POSC-11
R265	500k	±10%		POSC-11
R266	50k	±10%		POSC-11
R267	5k	±10%		POSC-11
R268	4.53M	±1%	1w	REF-3-2
R269	453k	±1%	1/4w	REF-65
R270	45.3k	±1%	1/4w	REF-65
R271	4.53k	±1%	1/4w	REF-65
R272	48.7M	±2%	2w	REF-3-3
R273	4.87M	±1%	1w	REF-3-2
R274	487k	±1%	1/4w	REF-65
R275	48.7k	±1%	1/4w	REF-65
R300	2.47k	±1%	1/4w	REF-65
R301	200k	±5%	1/2w	REC-20BF
R302	82k	±5%	1/2w	REC-20BF
R303	36k	±5%	1/2w	REC-20BF
R304	33k	±5%	1/2w	REC-20BF
R305	180k	±5%	1/2w	REC-20BF
R306	75k	±5%	1/2w	REC-20BF
R308	47k	±5%	1/2w	REC-20BF
R309	270k	±5%	1/2w	REC-20BF
R310	7.5k	±1%	1/3w	REPR-22
R311	1.0k	±10%		POSW-3
R312	3.6k	±1%	1/3w	REPR-22
R313	33k	±5%	1/2w	REC-20BF
R314	150k	±5%	1/2w	REC-20BF
R315	1.8k	±5%	1/2w	REC-20BF
R316	13k	±5%	1/2w	REC-20BF
R317	51k	±5%	1/2w	REC-20BF
R320	22k	±5%	1/2w	REC-20BF
R321	5.1k	±5%	1/2w	REC-20BF
R322	62k	±5%	1/2w	REC-20BF
R350	249k	±1%	1/2w	REF-70
R351	499k	±1%	1/2w	REF-70
R352	10M	±20%		POSC-11
R353	500k	±10%		POSC-11
R354	50k	±10%		POSC-11
R355	5k	±10%		POSC-11
R356	4.22M	±1%	1w	REF-3-2
R357	422k	±1%	1/4w	REF-65
R358	42.2k	±1%	1/4w	REF-65
R359	4.22k	±1%	1/4w	REF-65
R360	44.2M	±2%	2w	REF-3-3
R361	4.42M	±1%	1w	REF-3-2
R362	442k	±1%	1/4w	REF-65
R363	44.2k	±1%	1/4w	REF-65
R364	10M	±20%		POSC-11
R365	500k	±10%		POSC-11
R366	50k	±10%		POSC-11
R367	5k	±10%		POSC-11
R368	4.22M	±1%	1w	REF-3-2
R369	422k	±1%	1/4w	REF-65
R370	42.2k	±1%	1/4w	REF-65
R371	4.22k	±1%	1/4w	REF-65
R372	44.2M	±2%	2w	REF-3-3
R373	4.42M	±1%	1w	REF-3-2
R374	442k	±1%	1/4w	REF-65
R375	44.2k	±1%	1/4w	REF-65

RESISTORS

R400	2.40k	±1%	1/4w	REF-65
R401	75k	±5%	1/2w	REC-20BF
R402	10k	±5%	1/2w	REC-20BF
R403	82k	±5%	1/2w	REC-20BF
R404	33k	±5%	1/2w	REC-20BF
R405	33k	±5%	1/2w	REC-20BF
R406	5.1k	±5%	1/2w	REC-20BF
R407	1k	±5%	1/2w	REC-20BF
R408	1k	±5%	1/2w	REC-20BF
R409	33k	±5%	1/2w	REC-20BF
R410	7.5k	±5%	1/2w	REC-20BF
R411	5.1k	±5%	1/2w	REC-20BF
R412	39k	±5%	1/2w	REC-20BF
R413	22k	±5%	1/2w	REC-20BF
R414	10k	±5%	1/2w	REC-20BF

CAPACITORS. Capacitances are in μf unless otherwise indicated.

C1	200		12 dcwv	COE-6
C2	0.01	±10%	600 dcwv	COL-71
C30	0.1μf	+80-20%	50 dcwv	COC-63
C31	10μf		150 dcwv	COE-49
C32	10μf		150 dcwv	COE-49
C100	3.3	±10%	100 dcwv	COP-24
C101	200		12 dcwv	COE-6
C103	200		12 dcwv	COE-6
C200	100		25 dcwv	COE-35
C201	25		50 dcwv	COE-48
C202	60		25 dcwv	COE-47
C203	50		50 dcwv	COE-34
C204	0.022	±10%	100 dcwv	COW-17
C205	7-45μμf			COT-12
C206	10		50 dcwv	1554-44
C207	10		150 dcwv	COE-49
C208	10		150 dcwv	COE-49
C209	100		25 dcwv	COE-35
C210	10		150 dcwv	COE-49
C211A	150			
C211B	75		150 dcwv	COE-38
C211C	75			
C250	2.7-19.6μμf			COA-29-4
C251	15μμf	±10%	500 dcwv	COM-20B
C252	2.7-19.6μμf			COA-29-4
C253	2.7-19.6μμf			COA-29-4
C254	2.7-19.6μμf			COA-29-4
C255	2.7-19.6μμf			COA-29-4
C256	2.7-19.6μμf			COA-29-4
C257	2.7-19.6μμf			COA-29-4
C258	2.7-19.6μμf			COA-29-4
C259	2.7-19.6μμf			COA-29-4
C260A	13.5-603μμf			
C260B	13.5-603μμf			1554-40
C260C	13.5-603μμf			
C260D	13.5-603μμf			
C261	75μμf	±5%	500 dcwv	COC-62, NPO
C300	100		25 dcwv	COE-35
C301	25		50 dcwv	COE-48
C302	60		25 dcwv	COE-47
C303	50		50 dcwv	COE-34
C304	0.022	±10%	100 dcwv	COW-17

(continued)

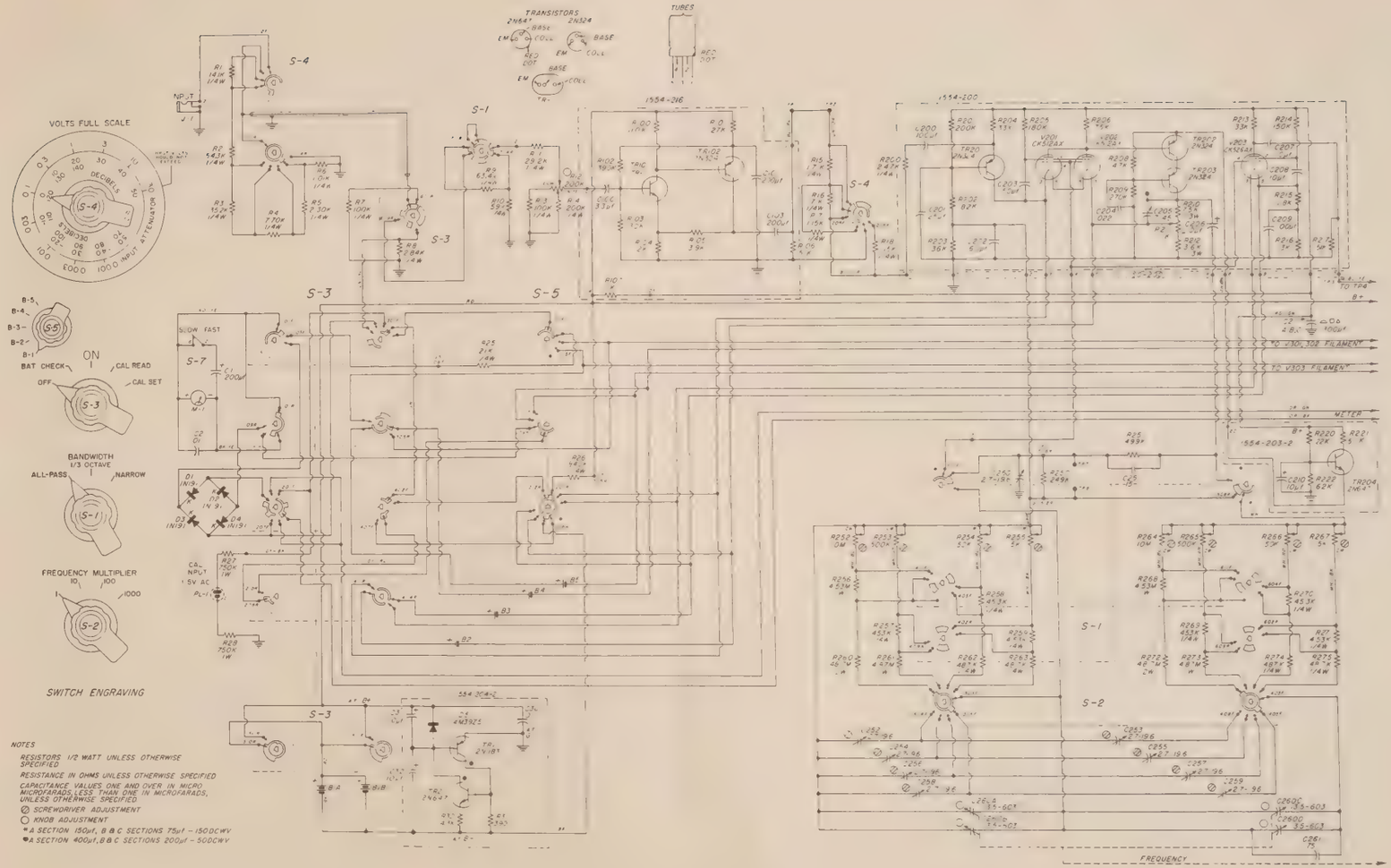


Figure 14A. Schematic Diagram (see also Figure 14B)

TABLE 2
TABLE OF TEST VOLTAGES AND RESISTANCES
(Refer to paragraph 4.9)

TUBE OR TRANSISTOR (TYPE)	PIN	ELEC-TRODE	VOLTS DC	RES TO GND
TR1 (2N1183)	1	C	-25	(A)
	3	B	-0.2	(A)
	5	E	0	(A)
TR2 (2N647)	1	C	-0.2	(A)
	3	B	-25	(A)
	5	E	-25	(A)
TR101 (TR1)*	1	C	10	110 k
	3	B	2.5	100 k
	5	E	2.5	2 k
TR102 (2N324)	1	C	6.0	5.9 k
	3	B	10.0	110 k
	5	E	10.5	26 k
TR201 TR301 (2N324)	1	C	6.5	4.1 k
	3	B	13.0	74 k
	5	E	13.7	34 k
TR202 TR302 (2N324)	1	C	22.0	∞
	3	B	25.5	76 k
	5	E	26.0	317 k
TR203 TR303 (2N324)	1	C	10.0	12.1 k
	3	B	21.0	270 k
	5	E	22.0	∞
TR204 TR304 (2N647)	1	C	32.0	5.1 k
	3	B	25.5	16.8 k
	5	E	26.0	317 k
TR401 (TR1)*	1	C	6.0	76 k
	3	B	3.0	18 k
	5	E	3.0	7.5 k
TR402 (2N647)	1	C	22.0	10 k
	3	B	6.0	76 k
	5	E	6.0	4.7 k
TR403 (2N647)	1	C	19.0	34 k
	3	B	11.0	26 k
	5	E	11.0	22 k

TUBE OR TRANSISTOR (TYPE)	PIN	ELEC-TRODE	VOLTS DC	RES TO GND
V201 V301 (CK512AX)	1	P	25.5	76 k
	2	S	25.5	181 k
	3	F	6.5	4.1 k
	4	G	(B)	282 k
	5	F	5.8	4.1 k
V202 V302 (CK512AX)	1	P	25.5	76 k
	2	S	25.5	181 k
	3	F	5.0	4.1 k
	4	G	(B)	282 k
	5	F	5.8	4.1 k
V203 V303 (CK526AX)	1	P	25.0	34 k
	2	S	22.0	151 k
	3	F	7.0	14.8 k
	4	G	(B)	282 k
	5	F	5.5	14.8 k
BATTERIES B1+			39.0	
B1-			-28.5	
TEST POINTS	TP 1		0	51 k
	2		0	2.53 k
	3		0	51 k
	4		0	2.53 k
	5		0	51 k
	6		0	2.86 k
	7		(B)	282 k
	8		4.0	32 k
	9		(B)	282 k
	10		4.0	32 k
	11		10.0	12.1 k
	12		10.0	12.1 k

(A) Do not attempt to measure these resistances.
(B) High-impedance circuit; cannot be measured with 20,000-ohm/volt meter. The dc voltage should be the same as at TP8, TP10.

*TR-1 is a Type 2N169A selected to have h_{FE} between 60 and 180 at 1 ma and 1 v.

PARTS LIST (Cont)

CAPACITORS. Capacitances are in µf unless otherwise indicated.			
C305	7-45µµf		COT-12
C306	10	50 dcwv	1554-44
C307	10	150 dcwv	COE-49
C308	10	150 dcwv	COE-49
C309	100	25 dcwv	COE-35
C310	10	150 dcwv	COE-49
C311A	150	150 dcwv	COE-38
C311B	75		
C311C	75		
C350	2.7-19.6µµf		COA-29-4
C351	15 ±10%	500 dcwv	COM-20B
C352	2.7-19.6µµf		COA-29-4
C353	2.7-19.6µµf		COA-29-4
C354	2.7-19.6µµf		COA-29-4
C355	2.7-19.6µµf		COA-29-4
C356	2.7-19.6µµf		COA-29-4
C357	2.7-19.6µµf		COA-29-4
C358	2.7-19.6µµf		COA-29-4
C359	2.7-19.6µµf		COA-29-4
C360A	13.5-603µµf		1554-40
C360B	13.5-603µµf		
C360C	13.5-603µµf		
C360D	13.5-603µµf		
C361	75µµf ±5%	500 dcwv	COC-62,NPO
C400	200	12 dcwv	COE-6
C401	25	50 dcwv	COE-48
C402	10	50 dcwv	1554-44
C403	100	25 dcwv	COE-35
C405	600	15 dcwv	COE-36
C406	100	25 dcwv	COE-35
C407A	150	150 dcwv	COE-38
C407B	75		
C407C	75		

DIODES					
D1	1N191	D3	1N191	D5	1/4M39Z5
D2	1N191	D4	1N191		

TRANSISTORS (SEE NOTES)			
TR1	2N1183	TR301	2N324
TR2	2N647	TR302	2N324
TR101	TR-1	TR303	2N324
TR102	2N324	TR304	2N647
TR201	2N324		
TR202	2N324	TR401	TR-1
TR203	2N324	TR402	2N647
TR204	2N647	TR403	2N647

TUBES			
V201	CK512AX	V301	CK512AX
V202	CK512AX	V302	CK512AX
V203	CK526AX	V303	CK526AX

BATTERIES		
B1A	67.5 v	Burgess XX45 or equivalent
B1B	67.5 v	Burgess XX45 or equivalent
B2	1.5	Rayovac 1LP or equivalent
B3	1.5	Rayovac 1LP or equivalent
B4	1.5 v	Rayovac 1LP or equivalent
B5	1.5 v	Rayovac 1LP or equivalent

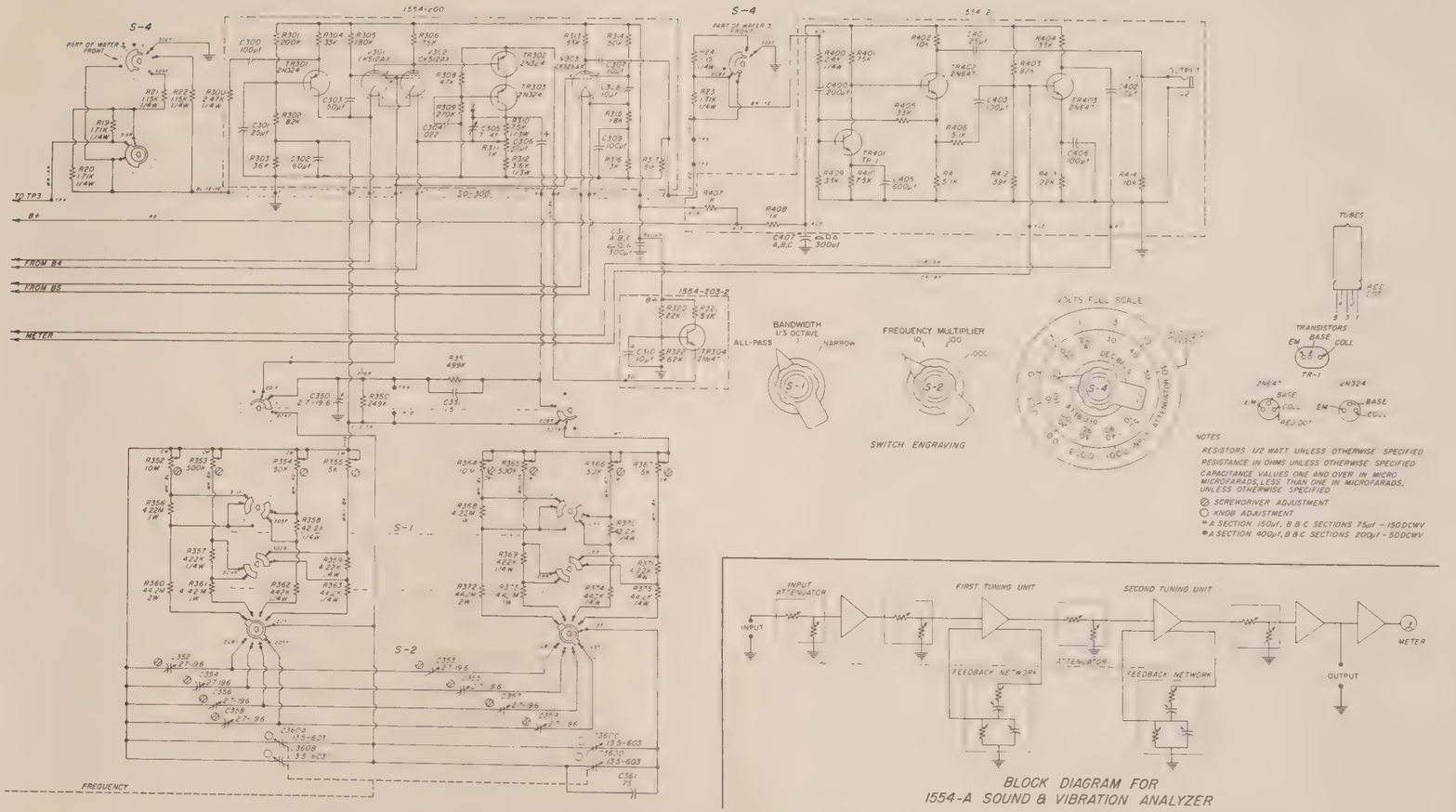
SWITCHES			
S1	SWRW-139	S4	SWRW-142
S2	SWRW-140	S5	SWRW-143
S3	SWRW-141	S7	SWT-323NP

MISCELLANEOUS		
J1	JACK	CDSJ-10
J2	JACK	CDSJ-820
M1	METER, 100µa	MEDS-119
PL1	PLUG	CDMP-1264-2
SO200	SOCKET	1554-117
SO300	SOCKET	1554-117

NOTE:

Type descriptions for resistors and capacitors are as follows:

COA - Capacitor, air	COW - Capacitor, wax
COE - Capacitor, electrolytic	POSC - Potentiometer, composition
COL - Capacitor, oil	POSW - Potentiometer, wire-wound
COM - Capacitor, mica	REC - Resistor, composition
COP - Capacitor, plastic	REF - Resistor, film
COT - Capacitor, trimmer	REPR - Resistor, precision



BLOCK DIAGRAM FOR
1554-A SOUND & VIBRATION ANALYZER

Figure 14B. Schematic Diagram (see also Figure 14A)

TYPE 1554-A SOUND AND VIBRATION ANALYZER

CUSTOMER EXPERIENCE QUESTIONNAIRE

1. Please indicate your uses for the Sound and Vibration Analyzer.

2. What equipment (manufacturer and model number) do you use in conjunction with the Analyzer?

3. What features or characteristics do you like about the Analyzer?

4. What limitations have you encountered?

5. Over what range of frequencies do you generally use the Analyzer?

6. To what relative extent do you use the narrow bandwidth and the 1/3-octave bandwidth?

7. Is battery operation quite satisfactory as provided?

8. Would provision for relay-rack mounting be an important convenience?

9. Do you have any specific improvements to suggest concerning mechanical design or operation characteristics?

10. Can you suggest any improvements in the presentation of information by the panel markings or in this instruction book?

11. Do you have any other comments or questions?

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